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WINTER HIBERNATION OF ANOPHELES LARVAE.

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It has been generally accepted that with the advent of cold weather anopheles larvae become inactive, and upon the freezing over of the water, or even before, they are destroyed. However, observations by Galli-Valerio and Roches de Johngh in Switzerland show that in Europe the larvae of certain species of mosquitoes hibernate in great numbers.[1] It is reported that larvae of Anopheles *bifurcatus* hibernate generally. These observers found that the species of anopheles with which they had to do could live in water between two sheets of ice.

As to the American species of anopheles there appears to be no record of observations or studies on their winter hibernation. Therefore the following notes will be of interest.

Full grown anopheles larvae were found by LePrince and the writer on December 1, at Crystal City, Mo., after several days of freezing temperatures.

Second and third molt anopheles larvae were found along the grassy edges of a sluggish stream at Greensboro, N. C., where a thin sheet of ice had formed over the water the night before. The larvae were active when dipped up.

Carter and Brumfield, on a survey in Fairfax County, Va., examined a pool (water varying from a few inches to a foot deep) on October 22 early in the day and were unable to find larvae; in the afternoon they again examined the pool and readily found them. The conclusion reached was that as the surface of the water was cold in the morning, the larvae remained at the bottom; but that when the water was warmed by the heat of the sun, they came to the surface. This is in accordance with observations of von Ezdorf, who stated that he had observed anopheles larvae which remained at the bottom of water for 20 minutes or more in cold or cool weather. He thought they were dead; but while being carried in a bottle placed in the pocket, they became active.

On November 23, 1917, third molt anopheles larvae were found by the writer in a shallow woodland pool and in small seepage pools at Yorktown, Va. Prior to this there had been several light freezes, one occurring the night before the larvae were taken. In the laboratory these larvae developed into anopheles *punctipennis*. In this survey practically no larvae were found, except in seepage water. They were not found in pools and streams where they are generally found in the breeding season.

Carter and Le Prince found anopheles larvae at Salkehatchie, S. C., on February 21 after cold weather. These developed into *puncti-*

[1] Howard, Dyer and Knabe, Monograph of the Mosquitoes of North and Central America and the West Indies.

pennis after being kept at room temperature. There were no small larvae found.

On December 18, at Alexandria, La., the writer found in a small, shallow pool, fed by seepage, about 15 full grown anopheles larvae. They were seen by stirring the water and waiting for them to come to the surface. The larvae were left here and observed at intervals ranging from a week to 10 days until February 22. During this time there were no small larvae in the pool. On the above date the larvae were put into a bottle and taken to the room; they pupated promptly, and imagos appeared by the fourth day; these were Anopheles *crucians*. On the second day the females took a blood meal, and the males died on the third day without food. The temperature record for Alexandria shows freezing temperatures as follows: October, 1917, 4 days (for the month, mean maximum, 76.4; mean minimum, 46.2); November, 8 days (mean maximum, 68.1; mean minimum, 38.3); December, 14 days (one day a minimum of 10°; for the month, mean maximum, 54.2; mean minimum, 36); January, 1918, 25 days (on two successive days minimum of 9°; for the month, mean maximum, 51.6; mean minimum, 29.2); February, 4 days (for the month, mean maximum, 67.4; mean minimum, 45.9). It was distinctly noticeable that in numerous seepage areas there was no difficulty in finding large anopheles larvae, whereas the finding of anopheles imagos in favorable places was rare.

At Newport News, Va., the writer found many full-grown anopheles larvæ in seepage pools on April 20, 1918, and repeated close examinations in various selected places failed to reveal any small larvæ before this date and for 10 days afterwards. Nor had there been temperature conditions prior to April 20 favorable to oviposition. The evidence is in favor of these larvæ having passed the winter as larvæ. In the laboratory larvæ from this collection developed *punctipennis* on April 24. The winter was a severely cold one for Tidewater, Va. James River and Hampton Roads froze over to such a degree that navigation was seriously interfered with. The following extract taken from the Weather Bureau Climatological Data shows the number of days of freezing temperature and the mean and monthly temperatures: October, 1917, 1 day (31st) freezing; November, 8 days freezing; December, 24 days freezing (1 day, minimum 2°; for the month, mean maximum, 39.8; mean minimum, 25.4); January, 1918, 30 days freezing (1 day a minimum of 1°; for the month, mean maximum, 37.0; mean minimum, 22.0); February, 14 days freezing (1 day a minimum of 6°; for the month, mean maximum, 51.6; mean minimum, 31.9); March, 3 days freezing (for the month, mean maximum, 61.1; mean minimum, 40.7).

CONCLUSIONS.

1. Anopheles (*crucians* and *punctipennis*, at least) pass the winter in the larval stage. This is true for northern Louisiana (for *crucians*) during a severe winter for that section. Evidence, though less conclusive, shows that *punctipennis*, at least, in the larval stage withstand a severe eastern Virginia winter.

2. Apparently pupation does not occur at low temperature, or until ordinary room temperature obtains.

3. In selected places considerable numbers of anopheles larvæ pass the winter as such.

4. Larvacides should be applied in the fall sufficiently late to kill the last batch of larvæ, or before season suitable for the completion of their aquatic stages in the spring.